Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE EFFECT OF MUSIC ON THORACIC BREATHING.

By EUGENIA FOSTER and E. A. MCC. GAMBLE.
With the assistance of L. J. BOYNTON, MAUDE DEWAR, and H. S. WHEELER.

(From the Psychology Laboratory of Wellesley College.)

This brief report is an addendum to the paper on "Attention and Thoracic Breathing" published in this *Journal* for July, 1905. The experiments here taken into account were made in the academic years 1903-1904 and 1904-1905 with the assistance of Dr. Hamilton C. Macdougall, head of the Wellesley College Department of Music. The purpose of the investigation was to find traces of any correlation which may exist between the emotional effects of different kinds of music and the varying features of respiration. Certain data furnished by the experiments of the first year have already been incorporated in the earlier paper. The attention and the music investigations necessarily overlap, since listening to music may be regarded not only as the possible condition of emotion but as involving a certain kind of attention. The music experiments of the first year constitute the third group of the attention experiments, and were, with the exception of the control experiments on the dog A., the last group to be made in that investigation.

In the earlier paper the reader will find (1) an account of the apparatus employed in these first music experiments (pp. 272-273) and (2) a discussion of the assumption on which the numerical results for different subjects were massed (pp. 274-275). Throughout the experiments of both investigations, virtually the same apparatus was used, rates of breathing were computed in the same manner, and the results of individual subjects were massed on the same principle. The two investigations diverge, however, in the method by which changes in the *form* as distinct from changes in the *rate* of breathing were estimated In the first year the determinations of form-changes were on various accounts very unsatisfactory. Some slight notice was taken of them in the earlier paper but they will be thrown out entirely here.

In the second year one or more experimental sittings were entirely allotted to determining the average normal breathing-rate of each subject. (On this use of the word "normal," see

p. 267 of the earlier paper.) The tracings thus obtained served as the primary standard of reference for determining the changes in the form of breathing (that is, in regularity, in amplitude, and in the length of the expiratory pause) which took place as the subject listened to music. In the latter half of this period a normal tracing was also taken at the beginning of each music-session to serve as a control upon changes in breathing due to alterations from day to day in the subject's mood and physical condition. At best, even in the second year of the music experiments, the determinations of changes in form were a matter of very rough estimate, and it would be scarcely worth while to give the statistics if their testimony were not upon certain points so unequivocal.

The subjects of the experiments, twenty-nine in number, were all young women, were all, with one exception, college students, and with two exceptions had no greater knowledge of music than is common in educated persons. Only four of the twenty-nine had had more than one year's work in psychology. Only one knew the exact purpose of the experiment. Every experimental sitting was limited to three-quarters of an hour. The music was furnished by Dr. Macdougall and was played upon the organ of the college chapel, an instrument of three manuals and thirty-nine speaking stops.

The problem of the investigation was two-fold. (1) Throughout the work the experimenters sought especially to discover differences in the effect of music in the major and in the minor keys. This variation in the stimulus was made not with any great expectation of finding such differences but in the hope that some other significant correlation might appear in the process of following the guiding-thread which came first to hand. (2) During the second year's work the tracings were studied to determine also the differences in effect between loud and soft music.

According to the music employed, the work falls into four periods. The results of each period can be most quickly understood if stated in close connection with the description of music used. For the sake of brevity, the discussion of results will be reserved till all are presented. The first three periods belong to the first year, and as noted above only changes in rate will here be discussed.

During the first period, eight subjects served for two sittings each. The music consisted of hymn-tunes. These were (1) the familiar tunes "Vox Dilecti" and "St. Andrew of Crete" and (2) two tunes in less ordinary use, "Warren" and "Nightfall."[1] In the first two tunes, there is a sharp transi-

[1] See in the hymn-book "In Excelsis" (The Century Company), numbers 231, 606, 99, and 100.

tion from minor to major. Each of these two tunes was played three times over, once as mechanically as possible with the minor and major passages at the same rate, once mechanically but with the major faster than the minor, and once with as much contrast between the two passages as could be secured by alteration of stops, tempo, and nuance,—the minor plaintive or solemn and the major triumphant. "Warren" and "Nightfall" were, in general, played twice both in the major and in the minor keys and with such differences in stops and tempo as to make the major lively and the minor mournful. A relief or relaxation-tracing (see page 273 of the earlier paper), not exceeding one minute in duration, was interpolated between two renderings of a melody and sometimes succeeded the last rendering. For this period the average normal breathing-rate was 16.7 inspirations per minute (there were 68 observations of about 3 minutes each, and the mean variation was 3.4); the average relief rate was 17.3 (obs. 69; M. V. 3.2); and the average rate for all the major passages was 18.9 (obs. 67; M. V. 3.8); and the average rate for all minor passages was 17.8 (obs. 65; M. V. 3.6). For all major passages mechanically played, except those in which the rate was noticeably faster than in the preceding minor, the average rate was 18.9 (obs. 23; M. V. 4.5); for the minors corresponding to these majors, the average rate was 17.8 (obs. 19; M. V. 4.3); for all the "relatively fast but mechanical majors," 19.3 (obs. 16; M. V. 4. 7); for all the "relatively slow but mechanical minors," 17.4 (obs. 16; M. V. 3.8); for all "lively majors," 18.6 (obs. 28; M. V. 3.4); for all "doleful minors," 18.1 (obs. 30; M. V. 3.1).

During the second period twelve subjects served for one or two sittings each. None of these individuals had served in the first period. The music consisted (1) of the choral in D major from Mendelssohn's Organ Sonata V and (2) of the choral in *D* minor from Mendelssohn's Organ Sonata VI. These chorals are severe in their style. Each was played mechanically five or six times for each subject. The same stops and tempo were used in both. First one was played two or three times, then the other, and so on. Relief tracings were interspersed among the music tracings as in Period I. The average normal breathing-rate for this period was 16.9 inspirations per minute (there were 48 cases and the mean variation was 4.5); the average relief-rate was 16.8 (obs. 86; M. V. 3.3); the average rate for all major passages was 18.2 (obs. 62; M. V. 3.6); and the average rate for all minor passages was 16.8 (obs. 65; M. V. 3.0).

During the third period of the experiment, six subjects served from three to six sessions each. All of these indi-

viduals had served during either the first or the second period. The music consisted of the following long compositions: (1) Gounod's "Funeral March of the Marionettes," (2) Rubinstein's "Torch-light Dance of the Brides of Cashmere," (3) The Dead March in Handel's "Saul," (4) Congerin's "Soeur Monique," (5) Handel's "Sarabande," (6) Chopin's "Prelude in D Flat" (7) the Allegretto from Mendelssohn's "Hymn of Praise," (8) Beethoven's "Andante in F," (9) the Adagio and March from Handel's "Occasional Overture." These pieces were used in order, as many with each subject as the time permitted. Each composition was, if necessary, cut, that it might occupy a time no longer than six minutes. Otherwise, it was played properly, and for all subjects, with the same registration and tempo, and so far as possible with the same variations in loudness. In general, each tracing which corresponded to an unbroken major or to an unbroken minor passage represented one case or observation although the "passage" might include the entire composition. In a few cases, however, the long tracings corresponding to the "Dead March" and to "Soeur Monique" were treated fractionally. For this period, the average normal breathing rate was 18.3 (obs. 76; M. V. 2.8); the average rate for all majors was 18.3 (obs. 85; M. V. 5.0); and the average rate for all minors was 17.2 (obs. 70; M. V. 4.9).

In the fourth and last period, which included the whole of the second year, ten subjects served, in general for five sittings each. Two of these sessions were occupied in obtaining records of normal breathing. Only one subject of the second year had served the year before. The music list was as follows: (1) Mendelssohn's Overture to Ruy Blas," (2) Schubert's "Moment Musicale," (3) Beethoven's "Slow Movement for the 7th Symphony," (4) Morandi's "Bell Rondo," (5) Guilmant's "Organ Sonata No. 2," (6) d'Evry's "Meditation," (7) Handel's overture to the "Occasional Oratorio," (8) (9) (10) Boëllman's "Suite Gothique," 1st, 2nd, 3rd movements, and finale, (11) Tschaikowsky's "Sweet Reverie," (12) Silas's "Organ Fantasie in D Minor," (13) Bennett's "Barcarolle," (14) Gounod's "Marche Militaire," (15) Spinney's "Berceuse," (16) Batiste's "St. Cecelia Offertoire in D Minor," (17) Suppe's "Overture to Poet and Peasant," (18) Chopin's "Prelude in D Flat Major." The principle of selection differed in the music of the third and fourth periods. The former had been chosen to present a large variety of major and minor passages; the latter was chosen to present the utmost variety of general æsthetic effect. Each piece was played in full and with feeling and, so far as possible, in the same manner for different subjects. The whole list was not,

however, used with all the different subjects. Three individuals heard the first fifteen pieces in order, but numbers 3, 4, 6, 7, 8, 9, 10, and 12 were soon dropped, as on various accounts unsuitable, and numbers 16, 17, and 18 added in their stead.

The experimenters committed two inadvertences in computing the breathing-rates for this period. The value of the experiment, however, does not justify working over the pneumograph tracings a second time. In the first place, the long records of normal breathing, which represented more than three-quarters of an hour, were not treated fractionally; on the contrary the total number of inspirations in these records was divided by the total number of seconds. Of course, normal rates so obtained cannot properly be compared with the normal rates of the first three periods since these were obtained from tracings not more than three and a third minutes long. In the second place, all the tracings for any one subject which corresponded to one given kind of music-stimulus (loud major, soft minor, or what not) in any one musical composition were treated together in series,—*i. e.*, the total number of inspirations was counted and divided by the total number of seconds. Thus each observation of a stimulus rate represents in Period 4 the total rate for that variety of passage (for all loud majors, for instance) for one subject in one whole composition. On the other hand, in Period 3 each observation of a stimulus-rate represents a single passage of the varieties of music to be compared (major and minor). So, also, even in this same Period 4 now under discussion, each observation of a form-change answers to a single passage of loud or soft major or minor music, although each observation of a breathing-rate answers, as just noted, to a series of such passages.

For this fourth period the average normal breathing-rate as computed from the short (three minute) normal tracings was 18.7 (observations, 12; M. V. 3.5); the average normal rate as computed from the long tracings (which often represent a condition bordering on drowsiness) was 16.3 (obs. 12; M. V. 3.4); the average rate for all loud major passages was 21.8 (obs. 59; M. V. 3.9); for all soft major passages, 20.8 (obs. 81; M. V. 3.5); for all loud minors, 21.9 (obs. 42; M. V. 3.8); for all soft minors, 21.2 (obs. 57; M. V. 3.8); for all majors, 21.3 (obs. 140; M. V. 3.6) for all minors, 21.5 (obs. 99; M. V. 3.8); for all loud passages, 21.9 (obs. 101; M. V. 3.9); for all soft passages, 20.9 (obs. 138; M. V. 3.6).

The changes in the form of breathing observed during this period are summarized in the following table which is modeled after Table I of the earlier paper.[1]

[1] In this table the word "revery" was inadvertantly omitted in the second column opposite the seventh line of figures.

TABLE

Showing changes in the form of breathing when listening to Loud and Soft Music in the Major and Minor Keys.

KIND OF MUSIC.	Number of observations.	Changes in regularity of				Changes in amount of			
		Amplitude.		Expiratory Pause.		Amplitude.		Expiratory Pause.	
		Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.	Increase.	Decrease.
		Cases %	Cases %	Cases %	Cases %	Cases %	Cases %	Cases %	Cases %
Loud Major.	151	34.4	37.1	15.1	32.9	8.3	70.6	13.4	69.0
Soft Major.	152	38.2	32.2	13.0	27.8	10.2	75.8	16.2	66.2
Loud Minor.	64	37.5	45.3	12.9	35.5	16.1	71.4	10.9	67.3
Soft Minor.	92	47.8	23.9	26.4	12.6	7.3	74.4	15.9	55.7

All the numerical results have now been presented. Before attempting to draw conclusions from them, it is necessary to note the introspective testimony of the subjects. In the fourth period, each subject was asked after every piece of music whether she had listened; if so, whether she had liked the music; and if she had not listened, what she had thought about. The same questions were asked less systematically in the third period. The replies showed that the subjects, on the average, paid fair attention and derived mild entertainment. On the whole, however, this attempt to secure æsthetic emotion under laboratory conditions appeared to fail flatly. In some very few cases, the subjects were "actively" engaged in trying to recall the name of the composition.

The following conclusions may be drawn from the numerical and introspective data now in hand: In the first place, it is evident from the table and from the rate-averages, that listening to music, loud or soft, major or minor, tends to shorten the expiratory pause and to make the breathing faster and shallower. These are effects characteristic of non-emotional mental "application."

In the second place, it is clear that the music-stimuli did not show any well marked tendency to make the breathing either more or less regular than the normal. The number of cases in which each change occurred fell short of fifty per cent. with every class of stimuli included in the table.

In the third place, no remarkable difference appears in the effect of either loud and soft or of major and minor music. Such slight and possibly accidental differences as do appear will be pointed out in detail. They are as follows: (1) The loud music had more effect than the soft (a) in shortening the

expiratory pause and (b) in accelerating the breathing. See (a) the table of form changes and (b) the rate-averages for Period 4. (2) The loud music had more effect than the soft in making the breathing shallower. See the table. (3) The loud music, if it affected the regularity at all, tended to decrease it. The soft minor music, if it had any effect on regularity, tended to increase it. The soft major music tended to increase rather than to decrease the regularity of the amplitude and to decrease rather than to increase the regularity of the expiratory pause. See the table. (4) The music in the major key had more effect upon the length of the pause than had the music in the minor key, not only shortening it but lengthening it in a greater number of cases. See the table. (5) The major passages had more effect in accelerating the breathing than had the minor passages. See the rate-averages for Periods 1, 2, and 3. The slight excess of the average for minors over the average for majors in Period 4 is doubtless due to the fact that the majors lengthened the expiratory pause in a significant minority of cases. On the other hand, the averages for minors in Periods 2 and 3 constitute exceptions (the latter a serious exception) to the accelerating effect of majors in general.[1]

The results thus summarized may perhaps be interpreted in the following fashion: It is clear that in listening to music the breathing tended to assume two of the features characteristic of mental application, namely, rapidity and shallowness, but did not tend to assume the third, namely, regularity. The explanation seems to be that the music, and especially the loud music, had sufficient intrinsic or "primary" value for attention to raise it to a fairly high level but not to keep it steady at that level. That is to say, the music attracted attention

[1] The results of the first three periods have been divided into cases of "slow" and of "rapid" breathing according to the average *normal* breathing-rate of the subjects from whom they were obtained. It has been found that in the case of rapid breathing, the average rate for all musical stimuli, taken together, fell slightly below the normal rate, whereas the average stimulus-rate for slow breathing rose slightly above the normal. (See page 291 of the earlier paper.) This showing accords with the general conclusion of the earlier paper that when the level of attention rises, the rate of breathing which has been faster than the average normal is much less accelerated than is the rate of slow breathing and may even be retarded. (See pp. 275 and 291.) It has not seemed worth while in the detailed interpretation of the music results to maintain this division into cases of slow and of rapid breathing. On the one hand, the mean variation in the normal rates of individual subjects is very large (see page 274 of the first paper), and on the other hand, without reference to individuals, the division in question cannot be made in this class of experiments because every stimulus-tracing has not a normal tracing of its own. (*Cf.* page 289 of the first paper.)

without steadily absorbing it, so as to blur the consciousness of surroundings or to inhibit suggested trains of thought.[1] The irregularity of breathing is thus to be interpreted as the symptom of revery. (See page 282 of the earlier paper and its quotation from Mosso.) It certainly was not sufficiently marked to indicate emotional disturbance. In the case of the loud passages, to be sure, the greater tendency toward irregularity and smaller tendency toward shallowness hint at occasional organic disturbance. This disturbance or "shock" is, however, sufficiently explained by the mere sensational intensity of the stimuli. It should be noted that the cases of irregularity cannot be explained by variations in rhythm or loudness *during the course* of a given stimulus. This theory will not serve because each observation of irregularity corresponds to a natural division in the music, a passage of fairly homogeneous character as to loudness, rhythm, and so on. To reiterate, the interpretation offered is that the breathing became more rapid and more shallow than the normal breathing because the level of attention rose, but did not become more regular because the stability of attention did not correspondingly increase.

One may now turn to the difference in effect between major and minor passages. The fact that the major passages accelerated the breathing more than did the minor passages may be explained, at least in part, by differences in the absolute time-rate at which the two were played and by differences in associations, verbal or non-verbal. This is the obvious interpretation of the breathing-rate averages of the first period. The difference between the effects of the slow minors and fast majors is especially noteworthy. But in the familiar hymn-tunes "Vox Dilecti" and "St. Andrew," even when both the major and minor passages were played mechanically and at the same rate, the major had the greater accelerating effect. This is doubtless to be explained by such verbal associations with the majors as "My thirst was quenched, my soul revived," and "Christian, up and smite them!" In the second period, that of the two chorals, the subjects probably paid less attention to the minor than to the major which was more familiar. By their own testimony, they were little impressed by either. Hence, perhaps, the anomalous result for the minor choral

[1] It will be remembered that Binet and Courtier found irregularity of breathing in somewhat similar experiments upon a single subject. These experimenters attributed it to "le développment des idées et des sentiments qui trouble la respiration, tout en tenant compte des effets spéciaux dus à la mélodie et à l'harmonie." (L'Année Psychologique, pp. 114–115.) In the present experiments, it is probable that full-bodied emotions were much less numerous than wandering trains of thought.

which, on the average, failed to accelerate the breathing at all. In the third and fourth periods, verbal associations were ruled out and the major passages were not more familiar than the minor. No data exist, however, for determining whether the difference in effect may or may not be explained by differences in tempo, in rhythm or in registration. As noted above, each major or minor passage was played once for each subject, and in the same manner for all subjects; variations in rate, rhythm and stops were not made in the playing of the same piece. In short, some slight essential difference in the effect of major and minor passages is neither proved nor disproved by this investigation.

The present study of the effect of music upon breathing has scarcely broken ground and has been suspended as requiring too prolonged and laborious co-operation on the part of an expert musician. It is, none the less, the opinion of the experimenters that a systematic numerical study might profitably be made of the changes produced in the rate and rhythm of breathing by variations in the rate and rhythm of music.